



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Viability of the seed bank under exotic aquatic weeds

Focus: SW, WU, CON

Key words: lake restoration, exotic weeds, biological control

Duration: 3/1/99-2/29/00

Fiscal year Federal funds: \$15,486

Non-federal funds: \$35,211

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Congressional District: 1, State of Vermont.

Statement of critical regional or state water problems

Aquatic communities can be highly productive and diverse. Freshwater plants create microhabitats and support a complex community of invertebrates, and fish. Lakes have been increasingly invaded by a variety of exotic plants. The accidental or intentional introduction of exotic plants into aquatic systems has often resulted in the rapid expansion of the populations of exotic species and a reduction in the abundance and species richness of native aquatic plants and animals.

Vermont waters have three exotic aquatic plants at nuisance levels; purple loosestrife, a emergent plant found throughout Vermont in marshes and wet ditches; water chestnut, a floating leaf plant found primarily in the southern basin of Lake Champlain; and Eurasian watermilfoil, a submersed plant which has been reported in 42 Vermont lakes. Eurasian watermilfoil is one of the most widespread nuisance aquatic weeds in North America. Eurasian watermilfoil was first recorded in Vermont in 1962 in Lake Champlain (Crosson 1987), relatively early in its spread throughout the rest of the United States and the southern provinces of Canada.

There are a number of Vermont lakes, such as Brownington Pond, Glen Lake, Lake Paran, and Lake Memphremagog, where there have been declines in Eurasian watermilfoil. However, native plants' responses to weed declines have been variable. In two lakes, native plant recovery has been rapid, while in other lakes, there has not yet been large scale re-establishment of native plants. Why do native plant communities respond so differently? The ability of native plants to recover may be a function of how extensive the exotic infestation was, and perhaps more importantly, how long the exotic plant dominated the lake.

In areas where exotics are dominant, few new seeds of native plants are deposited each year. Over time, seeds remaining in the sediment may become increasingly less viable. Where there has been long term and extensive domination, it is possible that few viable seeds from native plants remain in the seed bank. Is the ability of native plants in littoral areas of lakes to return to their former dominance a function of duration and extent of the infestation?

We will look at littoral areas that have been dominated by Eurasian watermilfoil or water chestnut. The primary focus, however, will be on Eurasian watermilfoil because this exotic is found in many more lakes throughout Vermont, while, currently, the distribution of water chestnut is restricted. The null hypothesis of this study is: there is no relationship between date of infestation by exotic weeds and native plant propagule species composition, richness or frequency.

Statement of results or benefits

There is a significant negative impact of exotic aquatic weeds on use of lakes, such as fishing, boating and recreation, and other public uses e.g. lakes as town water reservoirs. It is important to return littoral areas currently dominated by exotic weeds back to native plant communities as soon as possible. Native plants are critical for maintenance of healthy and diverse invertebrate and fish communities. Further, it is likely that complex beds of native plants will be more resistant to invasion when new exotic species enter in the future. If we understand the relationship between exotic extent and duration and the viability of native plant species, we could better predict which lakes may return to dominance by native plants without intervention. Lake managers could then target their efforts to lakes where native plants are less likely to recover, and therefore should be re-established by re-planting or seeding.

Most of the research proposed herein will be carried out at sites with Eurasian watermilfoil; however, we will also look at the seed bank in areas of water chestnut infestation.

Vermont is the ideal place for this study because the Eurasian watermilfoil invasion was extensive and has been very well documented by Vermont Department of Environmental Conservation. In addition, Vermont is one of the few places where the beginning dates of lake invasions by Eurasian watermilfoil range from 1962 to 1997 (Table 1).

While this research focuses on Vermont lakes, lakes throughout the US and Canadian provinces are infested with exotic weeds. The results of this research will help lake managers country-wide predict how much management effort will be needed for lake restoration.

Nature, scope, and objectives of the research

As in terrestrial systems, the accidental or intentional introduction of exotic plants into aquatic systems has often resulted in the rapid expansion of the populations of exotic

species and a reduction in the abundance and species richness of native aquatic macrophytes (e.g. Aiken et al. 1979, Carpenter 1980, Arthington and Mitchell 1986, Room 1990). One of the most widespread nuisance aquatic weeds in North America is Eurasian watermilfoil (Cofrancesco 1993).

The spread of Eurasian watermilfoil throughout North America has been a "text book" case of invasion by an exotic. The earliest confirmed record is from 1942 in the District of Columbia (Couch and Nelson 1986). As of 1998, Eurasian watermilfoil was found in 44 states and 3 provinces, and it continues to spread.

After Eurasian watermilfoil is introduced into a lake, it often becomes the dominant plant (e.g. Aiken et al. 1979, Carpenter 1980, Madsen et al. 1991). Biotically, Eurasian watermilfoil beds are different from mixed native beds. Native beds contain a complex, species-rich assemblage of macrophytes of variable height, growth form and leaf shape, resulting in many strata and microhabitats, which, in turn, support a highly diverse invertebrate community (Cyr and Downing 1988, Lodge et al. 1988). Eurasian watermilfoil beds, however, grow as thick, impenetrable walls of uniform height and leaf form. Plants grow quickly in the spring, and by mid-summer, Eurasian watermilfoil density in established beds can exceed 300 stems/m² (Madsen and Boylen 1988). Once at the water surface, stems spread laterally, forming a canopy shading the plants below.

Eurasian watermilfoil has been a successful competitor for light and nutrients. Finally, however, some Eurasian watermilfoil populations have declined and have been replaced by a mixed native plant -Eurasian watermilfoil assemblage. Most of these sites are associated with high densities of a North American aquatic weevil, which appears to act as a biological control of Eurasian watermilfoil (Sheldon 1997). These weevils are very species specific feeders on Eurasian watermilfoil.

In some areas of weevil-induced Eurasian watermilfoil declines, native plants grow up through the collapsing Eurasian watermilfoil plants (personal observations). In other lakes, native plants have been slow to become re-established. Native aquatic plant recruitment in areas of declining Eurasian watermilfoil should be a function of the propagule availability, abiotic conditions under the Eurasian watermilfoil mat, and competition with other native plants. Aquatic macrophytes can recruit from a variety of propagule types: asexually produced stolons, tubers, turions and other winterbuds, by fragmentation, and by seeds. Therefore, aquatic "propagule banks" can be diverse and complex, containing up to 29 species (van der Walk and Davis 1976).

The speed and extent of plant community recovery following Eurasian watermilfoil declines will depend on the plants coexisting with Eurasian watermilfoil in the understory, the "propagule bank", and recruitment from outside the bed. Propagules do not stay viable indefinitely. The extent of the understory, and the number and viability of propagules may be, in part, a function of how large the Eurasian watermilfoil bed is and how long it has been dominant.

Because Eurasian watermilfoil has been in some locations for decades, and in other lakes for only a few years, it is not difficult to find lakes with a wide range of infestation dates. In Vermont, Eurasian watermilfoil was first collected in the 1960's in Lake Champlain, and the weed did not spread to other lakes until the mid-1980's, after which it quickly invaded new lakes. Currently, lakes newly invaded by Eurasian watermilfoil are found once every 1-2 years (Table 1). Thus, in Vermont we can find lakes with duration of infestation ranging from 30 to < 2 years.